

an outlet orifice following downstream from the valve seat; and
a swirl-producing element arranged upstream from the fixed valve seat,

wherein:

the flattened face includes a diameter d that is greater than a diameter D of the
outlet orifice

REMARKS

I. Introduction

With the cancellation herein without prejudice of claim 11, claims 12 to 22 are pending in the present application. In view of the foregoing amendments and the following remarks, it is respectfully submitted that all of the presently pending claims are allowable, and reconsideration is respectfully requested.

Applicants note with appreciation the acknowledgment of the claim for foreign priority and the indication that copies of the certified copies of the priority documents have been received from the International Bureau.

Applicants thank the Examiner for considering the previously filed Information Disclosure Statements, PTO-1449 papers and cited references.

II. Entry in Part of Preliminary Amendment

The Office Action states that “[t]he preliminary amendment filed on May 31, 2001 has been entered in part” and that “[a]mendment to the specification has not been entered because it fails to comply with 37 CFR 1.121(b)(1)(ii) and 37 CFR 1.121(b)(1)(iii).” Office Action at p. 2. Applicants respectfully submit that the Preliminary Amendment was not filed on May 31, 2001, as incorrectly indicated in the Office Action, but was instead filed on February 27, 2001. As proof of the February 27, 2001 filing date of the Preliminary Amendment, annexed hereto are copies of: (1) “Notification of Acceptance of Application Under 35 U.S.C. 371 and 37 CFR 1.494 or 1.495” mailed on June 21, 2001, which specifically indicates that the Preliminary Amendment was filed on February 27, 2001; and (2) return postcard bearing a date stamp of receipt of February 27, 2001 and specifically indicating that a Preliminary Amendment was filed. Each of the foregoing acknowledges the February 27, 2001 filing date of the Preliminary Amendment. Pursuant to 65 Fed. Reg. 54603, Sept. 8, 2000, Amendments in compliance with former 37 C.F.R. § 1.121 were to be accepted until March 1, 2001. Accordingly, since

the Preliminary Amendment was filed before March 1, 2001, entry of the Preliminary Amendment in its entirety is respectfully requested.

III. Objection to the Drawings

The Office Action states that “the ‘direct injection of a fuel into a combustion chamber of the internal combustion engine’ recited in claim 12 must be shown or the feature(s) canceled from the claims.” Office Action at p. 2. As an initial matter, Applicants note that claim 12 does not include the language indicated above. However, claim 13 recites that “the fuel injector is for a direct injection of a fuel into a combustion chamber of the internal combustion engine.” The Specification states at page 3, lines 23 to 25 that “[t]he electromagnetically operated valve shown in Figure 1 as an example of an embodiment in the form of an injection valve for the fuel injection system of an internal combustion engine” and at page 3, lines 27 to 28 that “[t]his fuel injector is especially suitable as a high-pressure injection valve for direct injection of fuel into the combustion chamber of an internal combustion engine.” Since the fuel injector illustrated in Figure 1 is stated to be suitable as a high-pressure injection valve for direct injection of fuel into the combustion chamber of an internal combustion engine, it is respectfully submitted that at least Figure 1 adequately illustrates the limitation that “the fuel injector is for a direct injection of a fuel into a combustion chamber of the internal combustion engine” as recited in claim 13. Accordingly, it is respectfully submitted that the drawings fully comply with the requirements of 37 C.F.R. § 1.83, and withdrawal of this objection is therefore respectfully requested.

IV. Rejection of Claims 11 to 22 Under 35 U.S.C. § 112

Claims 11 to 22 were rejected under 35 U.S.C. § 112, second paragraph as indefinite for allegedly failing to particularly point out and distinctly claim the subject matter of the invention.

As regards claim 12, the Examiner will note that claim 12 has been amended herein without prejudice to recite “a valve closing section arranged on a downstream end of the valve needle” as described, for example, on page 4, line 30 to 31 of the Specification. No new matter has been added.

As further regards claim 12, the Examiner will note that claim 12 has been amended herein without prejudice to change “the outlet orifice” to --an outlet orifice--.

As regards claim 19, it is respectfully submitted that the “spray element” is not a double inclusion of the “valve seat element.” See, for example, page 8, lines 24 to 32 of the Specification. Furthermore, Figure 5 illustrates a valve-seat element 26 and a downstream spray-discharge element 67 having an outlet opening 32 and illustrates the spray-discharge element connected to the valve-seat element.

In view of the foregoing, it is respectfully submitted that claims 12 to 22 as amended herein fully comply with the requirements of 35 U.S.C. § 112. Withdrawal of this rejection is therefore respectfully requested.

V. Rejection of Claims 12 to 22 Under 35 U.S.C. § 103(a)

As an initial matter, Applicants note that the Office Action states that claims 11 to 21 added in the Preliminary Amendment were renumbered as claims 12 to 22. However, the Office Action states at page 4 that “[c]laims 11-21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Imafuku et al. . . . in view of Shen et al.” and that “[c]laims 11-21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ren et al.” It is believed that the Office Action contains typographical errors and that the rejection was intended to be applied to claims 12 to 22. Applicants address this rejection as so applied.

Claims 12 to 22, as understood based on the foregoing, were rejected under 35 U.S.C. § 103(a) as unpatentable over the combination of U.S. Patent No. 4,890,794 (“Imafuku et al.”) and U.S. Patent No. 5,878,962 (“Shen et al.”) or as unpatentable over U.S. Patent No. 5,996,912 (“Ren et al.”). For the reasons more fully set forth below, Applicants respectfully submit that the combination of Imafuku et al. and Shen et al. does not render obvious the present claims and that Ren et al. does not render obvious the present claims.

Claim 12 relates to a fuel injector for a fuel injection system of an internal combustion engine. Claim 12 recites that the fuel injector includes an energizable actuating element, a valve needle that is axially movable along a longitudinal axis of a valve, a fixed valve seat, a valve seat element including an orifice following downstream from the fixed valve seat, and a valve closing section arranged on a downstream end of the valve needle and for working together with the fixed valve seat for opening and closing the valve, the fixed valve seat designed on the valve seat element. Claim 12 further recites that the fuel injector includes a flattened face running perpendicular to the longitudinal axis of the valve and being arranged on the downstream end of the valve closing section downstream from the fixed

valve seat and a swirl-producing element arranged upstream from the fixed valve seat, the flattened face including a diameter d that is greater than a diameter D of an outlet orifice.

Imafuku et al. purport to relate to a perforated body for a fuel injection valve, Shen et al. purport to relate to a pressure swirl injector with an angled cone spray for fuel injection, and Ren et al. purport to relate to a flat needle for pressurized swirl fuel injection. One of skill in the art at the time the invention claimed in the present application was made would not think to combine Imafuku et al. and Shen et al., particularly in the design of a fuel injector with improved fuel preparation with features upstream of the valve seat. Shen et al. purport to induce a swirl pattern flow to reduce turbidity in the channel generated in angling the flow at the spray end. As the object of the Shen et al. is the creation of an effective conical spray situated angularly from the injector axis, the subject and description of Shen et al. are directed toward counteracting the sharp corners, protuberances and pockets inherent in such a flow pattern. This is a markedly different subject than Applicants' formation of a pre-stream in a fuel injector to optimize fuel preparation. Also contrary to the claims is the description of Imafuku et al., which purport to address a perforated body downstream of the valve sealing seat. One skilled in this art seeking to improve the fuel preparation of an injector would not look to such perforated bodies situated downstream to direct the flow as described by Imafuku et al.

Moreover, it is respectfully submitted that Shen et al. teach away from the pre-stream formation located upstream from the closed valve of the present claims. Shen et al. state that the purpose of the "swirler" is to swirl the fuel flowing through the orifice when the valve is in an open position. This is in stark contrast to the purpose of the swirl-producing element of the present invention, which forms the pre-stream in front of the valve seat when the valve is closed. Still further, Shen et al. specifically envision the fuel flow to have "strong swirl effected by the swirl plate" as it exits the open valve. See col. 5, lines 31-32. This flow produced by the object of Shen et al. is in stark contrast to the flow that results from the pre-stream preparation performed by the swirl-producing device according to the present invention. When the valve in the present invention opens, most of the fuel flows without a swirl in a predominantly axial manner toward the outlet orifice situated downstream from the valve. This flow prepares the fuel to exit in a finer fuel spray and with reduced energy loss. In addressing the pre-stream fuel preparation of the present invention, one skilled in this art at the time the invention was may would be taught away by the disclosure of Shen et al., which

addresses the production of “strong swirl” for the purpose of counteracting the disadvantageous flow pattern produced by angling the flow off of the axis of the valve.

Imafuku et al. also teach away from the claimed invention. The perforated body of Imafuku et al. through which the fuel will flow is situated downstream from the valve seat. Col. 6, lines 35 to 36. Thus, Imafuku et al. would teach one skilled in the art away from the subject matter of the present invention. The focus of Imafuku et al. is the flow of the fuel after exiting the valve seat, including inclination of the flow direction to aim the fuel angularly from longitudinal axis of the injector. Col. 2, lines 37 to 41. Thus, Imafuku et al. do not describe, or even suggest, pre-stream preparation of the fuel to improve the axial flow for reduced droplet size and reduced energy loss.

The opening in the end plate described by Shen et al. is connected to a tube with a flow passage in communication with the opening. Col. 5, lines 58 to 60. This orientation is not analogous to the flattened face of the present invention. As described by Shen et al., the flow exits the opening end plate to flow through an enclosed tube which is positioned angularly to the axis of the injector. This is not the same as the flow exiting the flat face with diameter d greater than that of diameter D of the outlet orifice of the present invention. Not only are the elements not the same, experimentation on one would not produce any usable values for the dimensions of the non-analogous element as different forces and phenomena are at work.

As regards Ren et al., Ren et al. describe the sharp circular edge with the flat end face created by the flat end face having a smaller diameter than the orifice of the valve seat. The sharp circular edge address the need to reduce variations in the spray cone angle and flow rate, according to Ren et al. Col. 1, lines 62 to 63. Ren et al. specifically teach away from the limitations of the present claims in addressing the problems with spray cone angle and flow rate. The claims of the present invention delineate that the flattened face has a diameter smaller than that of the outlet orifice. One skilled in this art would be taught away from such a ratio by the description of Ren et al. of creation of a sharp circular edge with the exact opposite ratio. Further, Ren et al. would not educate toward the present invention as Ren et al. describes a large angular velocity created by swirl elements to improve fuel discharge, instead of the axial flow of the present invention.

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Furthermore, the injector described by Imafuku et al. has a valve needle 27, which ends downstream from the sealing seat in a cylindrical plug 45. The plug 45 at the

downstream end of valve needle 27 is used to form an annular gap between cylindrical nozzle body opening 50 and plug 45, the annular gap having a constant cross-section over its length. See, col. 3, lines 1 to 5. The length of plug 45 is designed such that plug 45 just fails to protrude from nozzle-body opening 50 when the fuel injector is closed, *i.e.*, plug 45 ends directly in front of the plane defined by an upper end face 51 of nozzle body 9. See, col. 3, lines 12 to 17. In this respect, plug 45 therefore ends just directly above the disk-shaped orifice element 55 as well, which has several spray-discharge openings 54a, 54b. In order to not close spray-discharge openings 54a, 54b and to ensure that the fuel flows into spray-discharge openings 54a, 54b in an unhindered manner, using just plug 45 and the annular gap formed around it, spray-discharge openings 54a, 54b are purposely introduced in orifice element 55 so as to be *offset* from plug 45 *without overlapping it at all*, as illustrated in Figure 2 and described in col. 4, line 60 to col. 5, line 2.

If one would install such a valve needle in an injector as described by Shen et al., the spray-discharge opening would simply be plugged. Valve needles having plug-like end pieces may only be used in injectors, in which an annular space through which fuel passes is provided around the plug. The structural design of the valve needles of both types of valves is fundamentally different, so that it is not at all possible to exchange the valve needles, since non-functioning valves would be created. In this respect, it is respectfully submitted that a person of ordinary skill in the art would not be motivated to combine the disclosures of Imafuku et al. and Shen et al. to obtain a functioning injector. Rather, it is respectfully submitted that a person of ordinary skill in the art would realize that a useful combination would be ruled out.

In contrast, the fuel injector according to the present invention has the advantage of, *e.g.*, improved fuel preparation. The improvement in the processing quality particularly relates to the so-called pre-jet, which is formed from fuel that has gathered in an inner swirl chamber of the swirl-producing arrangement in front of the valve seat, when the valve is closed. When the valve is opened, this fuel flows essentially axially and without angular momentum to the outlet opening situated downstream from the valve seat. Only immediately afterwards is it joined by the actual main jet, which is discharged with angular momentum due to its flowing through the swirl element.

The preparation of the fuel in the pre-jet may be improved by the geometry of the present invention at the downstream valve needle tip and the dimensional ratios of the valve needle tip to the spray-discharge geometry. The starting flow forming the pre-jet and

the formation of a wall film in the outlet opening may be very strongly influenced by the configuration of the present invention of the relatively wide, *i.e.*, large-diameter, flattened region at the valve needle tip, which also forms the flow region of the turbulent flow. The size of the drop may be decreased, which means that a finer fuel spray may be discharged. The energy loss of the fuel at the flattened region of the valve needle reduces the expansion of the more harmful pre-jet. The homogeneity of the main jet may also be increased in this manner.

In rejecting a claim under 35 U.S.C. § 103(a), the Examiner bears the initial burden of presenting a *prima facie* case of obviousness. *In re Rijckaert*, 9 F.3d 1531, 1532, 28 U.S.P.Q.2d 1955, 1956 (Fed. Cir. 1993). To establish *prima facie* obviousness, three criteria must be satisfied. First, there must be some suggestion or motivation to modify or combine reference teachings. *In re Fine*, 837 F.2d 1071, 5 U.S.P.Q.2d 1596 (Fed. Cir. 1988). This teaching or suggestion to make the claimed combination must be found in the prior art and not based on the application disclosure. *In re Vaeck*, 947 F.2d 488, 20 U.S.P.Q.2d 1438 (Fed. Cir. 1991). Second, there must be a reasonable expectation of success. *In re Merck & Co., Inc.*, 800 F.2d 1091, 231 U.S.P.Q. 375 (Fed. Cir. 1986). Third, the prior art reference(s) must teach or suggest all of the claim limitations. *In re Royka*, 490 F.2d 981, 180 U.S.P.Q. 580 (C.C.P.A. 1974). As more fully set forth above, it is respectfully submitted that the combination of Imafuku et al. and Shen et al. does not disclose, or even suggest, all of the limitations of claim 12, and Ren et al. do not disclose, or even suggest, all of the limitations of claim 12. It is therefore respectfully submitted that the combination of Imafuku et al. and Shen et al. does not render obvious claim 12 and that Ren et al. do not render obvious claim 12.

Moreover, it is respectfully submitted that the cases of *In re Fine*, *supra*, and *In re Jones*, 21 U.S.P.Q.2d 1941 (Fed. Cir. 1992), make plain that the Office Action's generalized assertions that it would have been obvious to modify or combine the references do not properly support a § 103 rejection. It is respectfully submitted that those cases make plain that the Office Action reflects a subjective "obvious to try" standard, and therefore does not reflect the proper evidence to support an obviousness rejection based on the references relied upon. In particular, the Court in the case of *In re Fine* stated that:

The PTO has the burden under section 103 to establish a *prima facie* case of obviousness. It can satisfy this burden only by showing some objective teaching in the prior art or that knowledge generally available

to one of ordinary skill in the art would lead that individual to combine the relevant teachings of the references. This it has not done. . . .

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Instead, the Examiner relies on hindsight in reaching his obviousness determination. . . . One cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention.

In re Fine, 5 U.S.P.Q.2d at 1598 to 1600 (citations omitted; italics in original; emphasis added). Likewise, the Court in the case of *In re Jones* stated that:

Before the PTO may combine the disclosures of two or more prior art references in order to establish *prima facie* obviousness, there must be some suggestion for doing so, found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. . . .

Conspicuously missing from this record is any evidence, other than the PTO's speculation (if it be called evidence) that one of ordinary skill . . . would have been motivated to make the modifications . . . necessary to arrive at the claimed [invention].

In re Jones, 21 U.S.P.Q.2d at 1943, 1944 (citations omitted; italics in original).

That is exactly the case here since it is believed and respectfully submitted that the present Office Action offers no evidence whatsoever, but only conclusory hindsight, reconstruction and speculation, which these cases have indicated does not constitute evidence that will support a proper obviousness finding. Unsupported assertions are not evidence as to why a person having ordinary skill in the art would be motivated to modify or combine references to provide the claimed subject matter of the claims to address the problems met thereby. Accordingly, the Office must provide proper evidence of a motivation for modifying or combining the references to provide the claimed subject matter.

More recently, the Federal Circuit in the case of *In re Kotzab* has made plain that even if a claim concerns a “technologically simple concept” -- which is not the case here -- there still must be some finding as to the “specific understanding or principle within the knowledge of a skilled artisan” that would motivate a person having no knowledge of the claimed subject matter to “make the combination in the manner claimed,” stating that:

In this case, the Examiner and the Board fell into the hindsight trap. The idea of a single sensor controlling multiple valves, as opposed to

multiple sensors controlling multiple valves, is a technologically simple concept. *With this simple concept in mind, the Patent and Trademark Office found prior art statements that in the abstract appeared to suggest the claimed limitation. But, there was no finding as to the specific understanding or principle within the knowledge of a skilled artisan that would have motivated one with no knowledge of Kotzab's invention to make the combination in the manner claimed.* In light of our holding of the absence of a motivation to combine the teachings in Evans, we conclude that the Board did not make out a proper *prima facie* case of obviousness in rejecting [the] claims . . . under 35 U.S.C. Section 103(a) over Evans.

In re Kotzab, 55 U.S.P.Q.2d 1313, 1318 (Fed. Cir. 2000) (emphasis added). Again, it is believed that there have been no such findings.

Accordingly, there is no evidence that the references relied upon, whether taken alone, combined or modified, would provide the features and benefits of claim 12. It is therefore respectfully submitted that claim 12 is allowable for these reasons.

As for claims 13 to 22, which ultimately depend from claim 12 and therefore include all of the limitations of claim 12, it is respectfully submitted that the combination of Imafuku et al. and Shen et al. does not render obvious these dependent claims for at least the same reasons given above in support of the patentability of claim 12 and that Ren et al. do not render obvious these dependent claims for at least the same reasons given above in support of the patentability of claim 12. *In re Fine, supra* (any dependent claim depending from a non-obvious independent claim is non-obvious).

VI. Conclusion

In view of the foregoing amendment and remarks, it is respectfully submitted that all pending claims of the present application are now in condition for allowance. Prompt reconsideration and allowance of the present application are therefore earnestly solicited.

Attached hereto is a marked-up version of the changes made to the claims by the current Amendment. The attached page is captioned, "Version with Markings to Show Changes Made."

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Claim 12 has been amended without prejudice as follows:

12. (Amended) A fuel injector for a fuel injection system of an internal combustion engine, comprising:

an energizable actuating element;

a valve needle that is axially movable along a longitudinal axis of a valve;

a fixed valve seat;

a valve seat element including an orifice following downstream from the fixed valve seat;

a valve closing section arranged on a downstream end of the valve needle and for working together with the fixed valve seat for opening and closing the valve, wherein:

the fixed valve seat is designed on the valve seat element;

a flattened face running perpendicular to the longitudinal axis of the valve and being arranged on the downstream end of the valve closing section downstream from the fixed valve seat; and

a swirl-producing element arranged upstream from the fixed valve seat, wherein:

the flattened face includes a diameter d that is greater than a diameter D of [the] an outlet orifice.